The Assembly and Evolution of the Amazonian Biota and its Environment

Dimensions of Biodiversity US-BIOTA-São Paulo

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www.amazoniabiodiversity.org

FAPESP

NSF

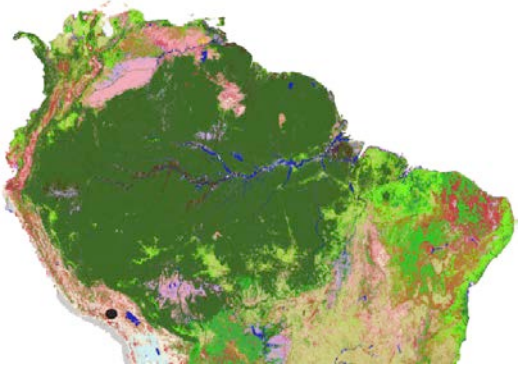
NASA

bioGENESIS
a core project of DIVERSITAS

Amazonia: vast, diverse and important

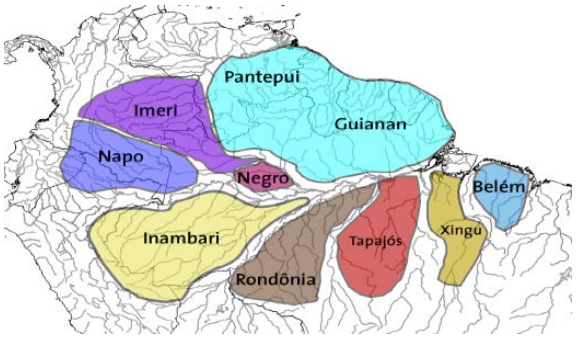
Vast

- Portions of nine nations
- Seven million square kilometers



Diverse

- Huge taxonomic/ecological diversity
- Complex and deep environmental history



Globally important

- Total forest biomass ~100 billion tons C
- 20% of atmospheric O_2
- 10% global terrestrial NPP
- 15-20% global freshwater flows
- 25 million people (2010)
- forest cover continues to be lost

Scientific challenges and goals

- How is genetic, taxonomic, and ecological diversity distributed within Amazonia?
- What has been the evolutionary history of the Amazonian biota and how was it generated?
- What has been the history of the Amazonian aquatic and terrestrial environments?
- How has the Amazonian environment and its biota evolved together, and what have been the global effects of this evolutionary-ecological system over time?

Requires a new integrated approach

NSF-FAPESP-NASA project: broad-scale collaboration

Brazil

- Universidade de São Paulo
- Universidade Federal de Goiás
- Universidade Federal do Pará
- Universidade Estadual de Campinas
- Museu Paraense Emílio Goeldi
- Instituto Nacional de Pesquisas da Amazônia

Argentina

- CONICET-Instituto Superior de Entomologia, Tucumán

Great Britain

- University of Edinburgh

Canada

- University of Toronto

United States

- American Museum of Natural History
- City University New York
- Field Museum of Natural History
- Middle Tennessee State University
- Natural History Museum Los Angeles County
- New York Botanical Garden
- University of Michigan
- University of Colorado

First annual collaborator meeting
Saõ Paulo, Brazil
4-8 March 2013

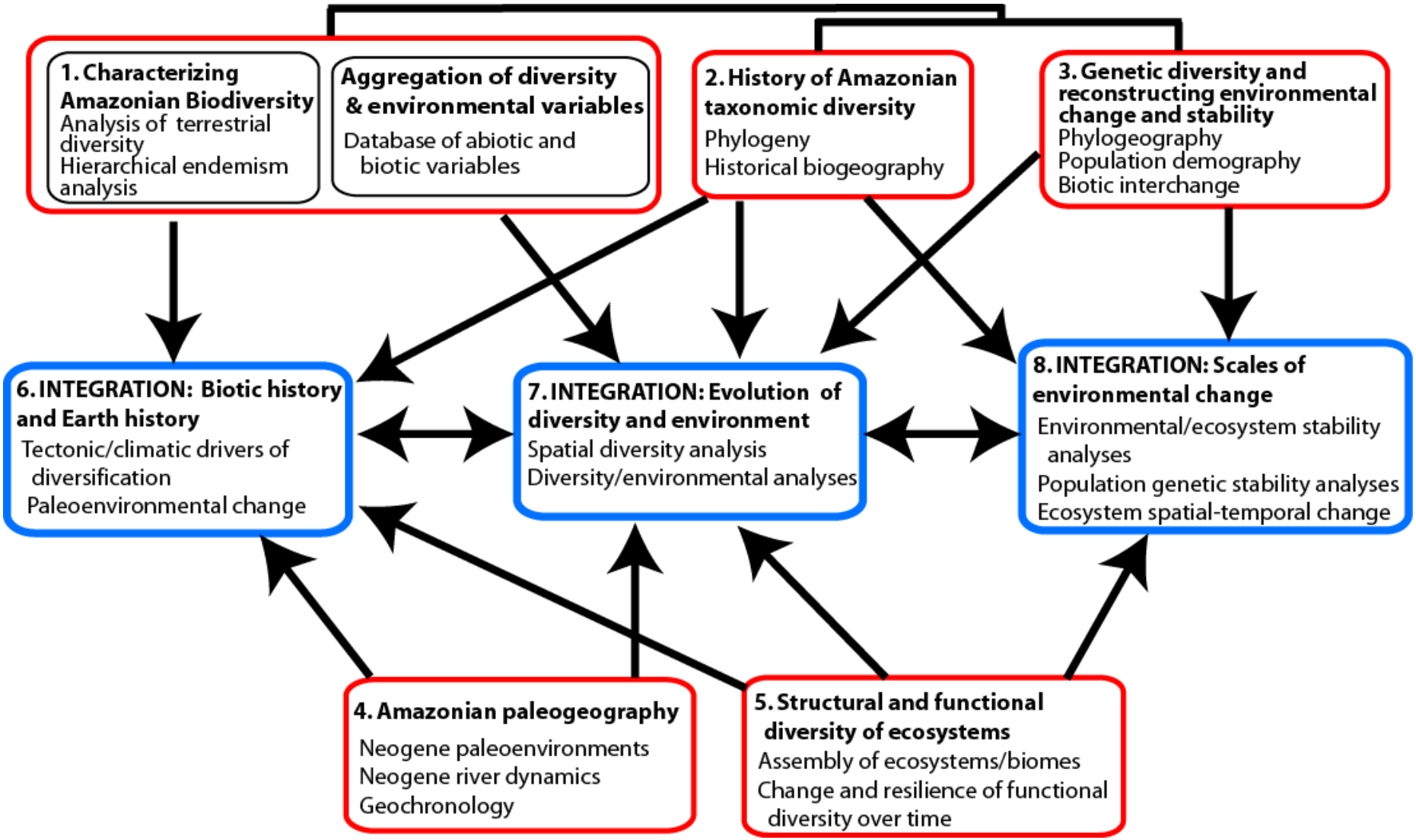
1. Open public symposium on Amazonian biota and environment

2. Four days of interactive planning meetings

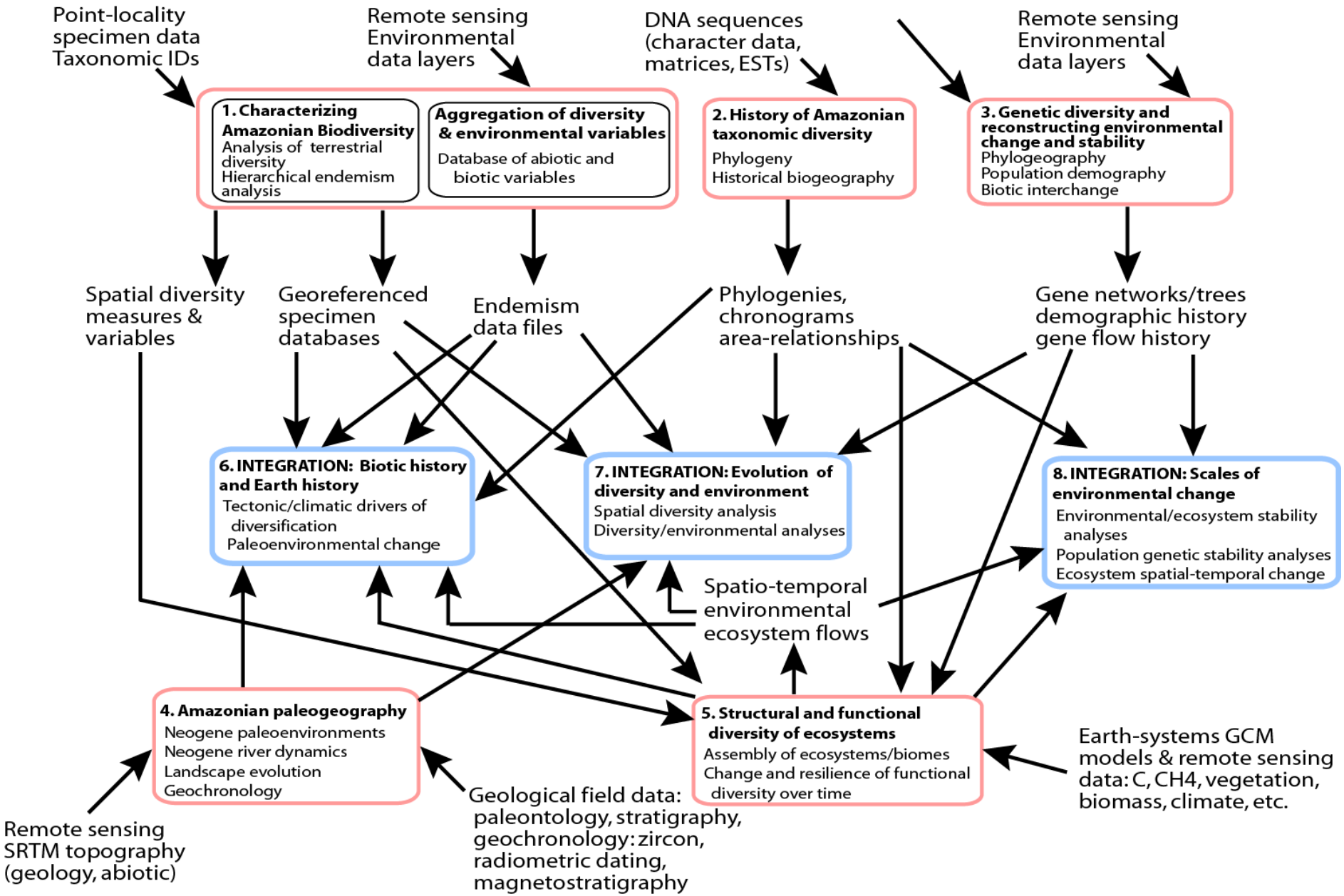
FAPESP Symposium

Collaborators

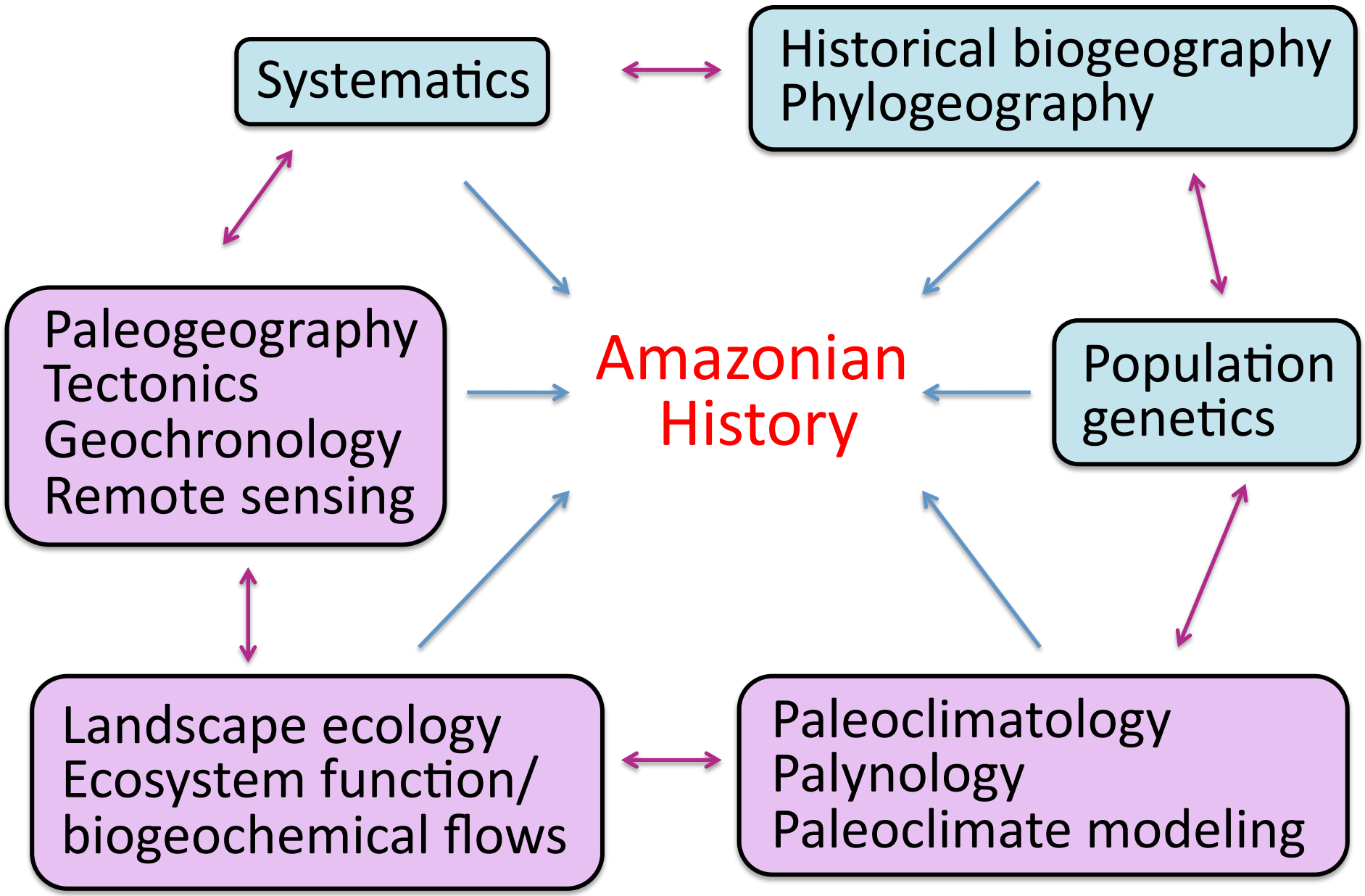
Meeting the scientific challenges calls for integrative cross-disciplinary studies



Expected data flows



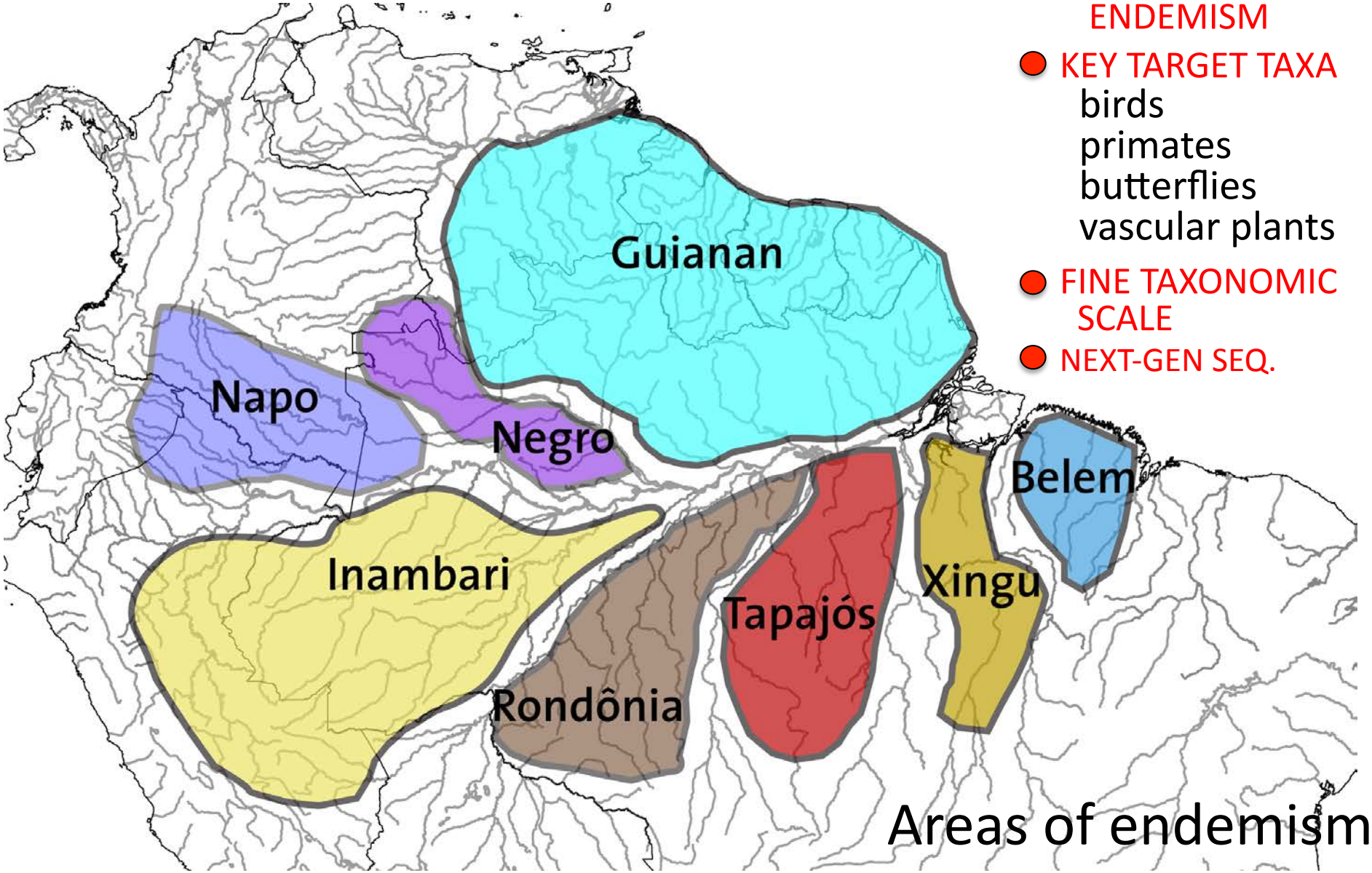
Integration across disciplines



Reconstructing the history of the Amazonian biota and environment: some examples of integration

Integrating phylogenetic history and paleogeography

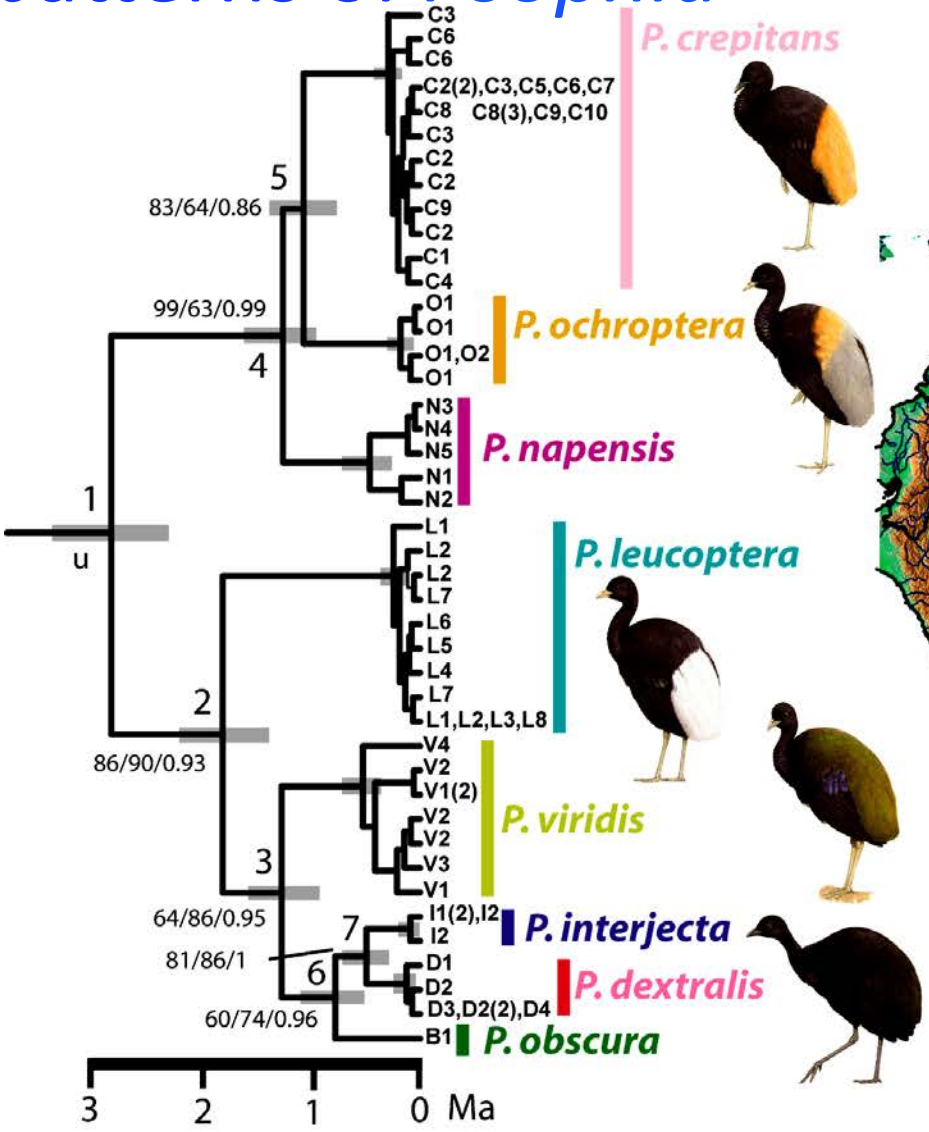
- QUANTITATIVE DISTRIBUTION & ENDEMISM
- KEY TARGET TAXA
  - birds
  - primates
  - butterflies
  - vascular plants
- FINE TAXONOMIC SCALE
- NEXT-GEN SEQ.

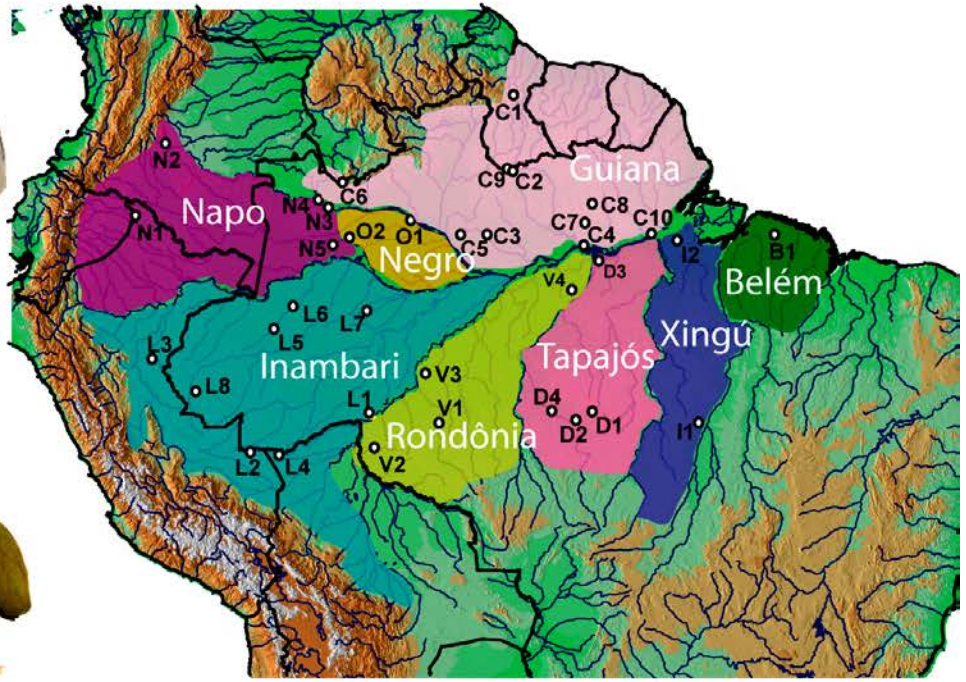


Areas of endemism

Phylogenetic and biogeographic patterns of *Psophia*

Ribas et al. *PRS* 2012





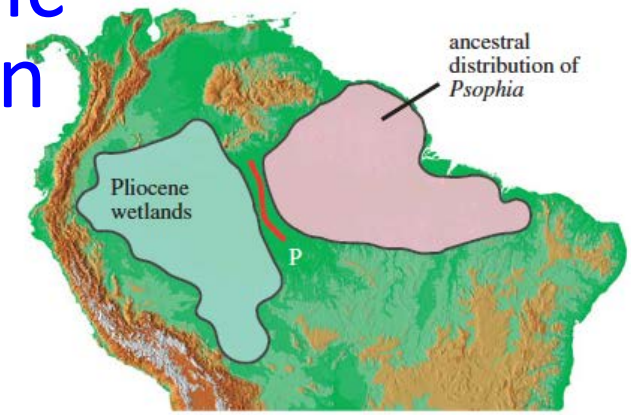
North Amazon/South Amazon east/west patterns

Timeline estimated by two independent methods

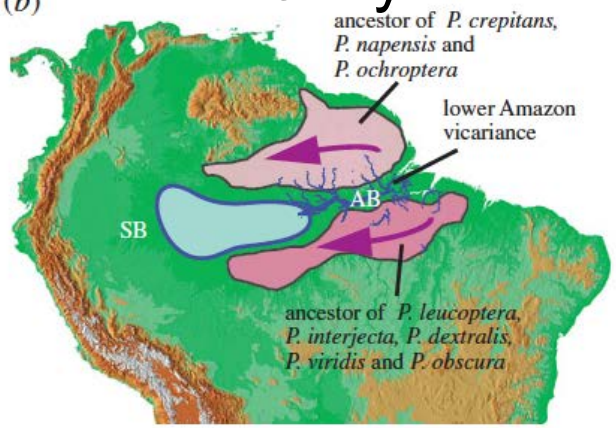
Leads to a predictive Amazonian paleogeography: testing alternative models

Paleogeographic model based on *Psophia*

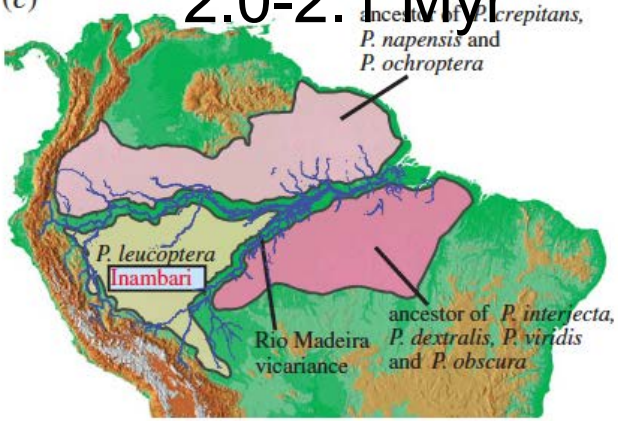
3.0-2.7 Myr



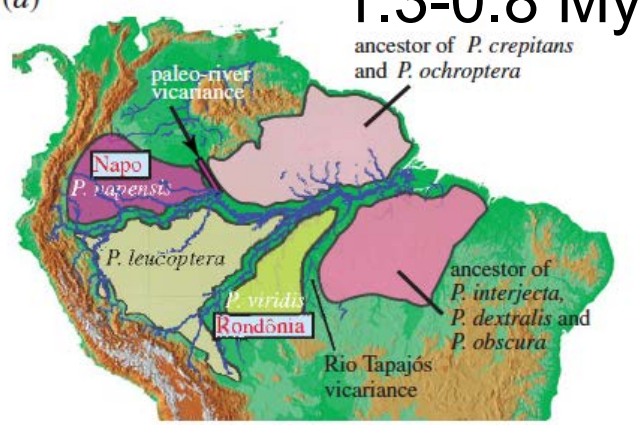
(b) 2.7-2.0 Myr



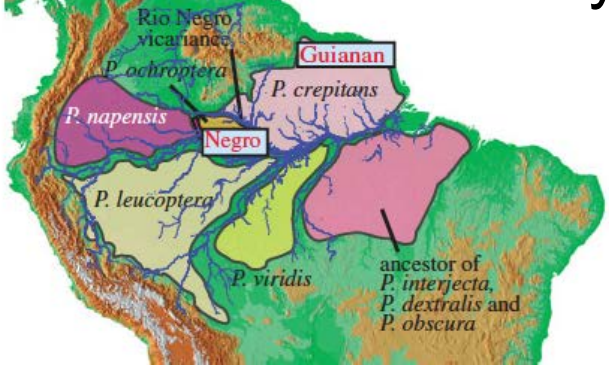
(c) 2.0-2.1 Myr



(d) 1.3-0.8 Myr



(e) 1.0-0.7 Myr



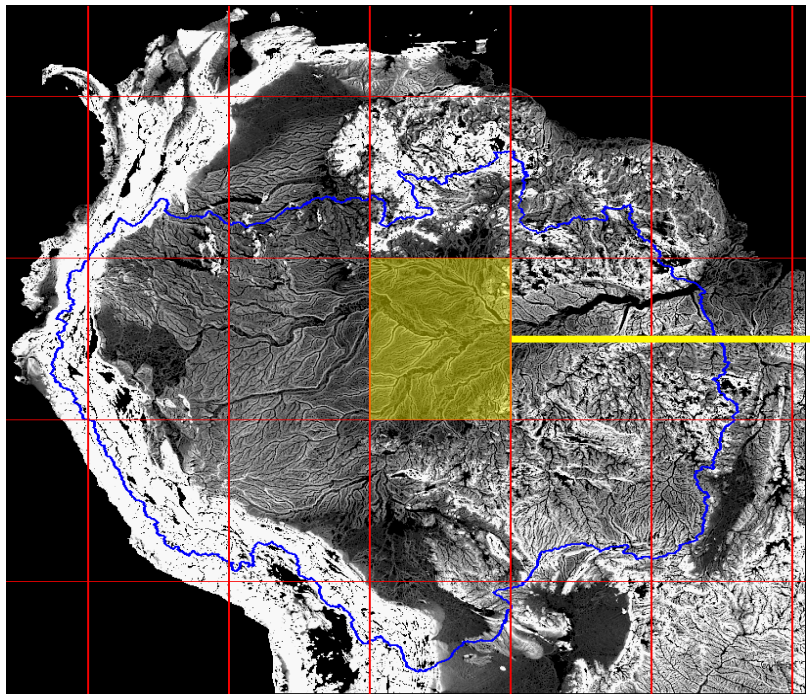
(f) 0.8-0.3 Myr

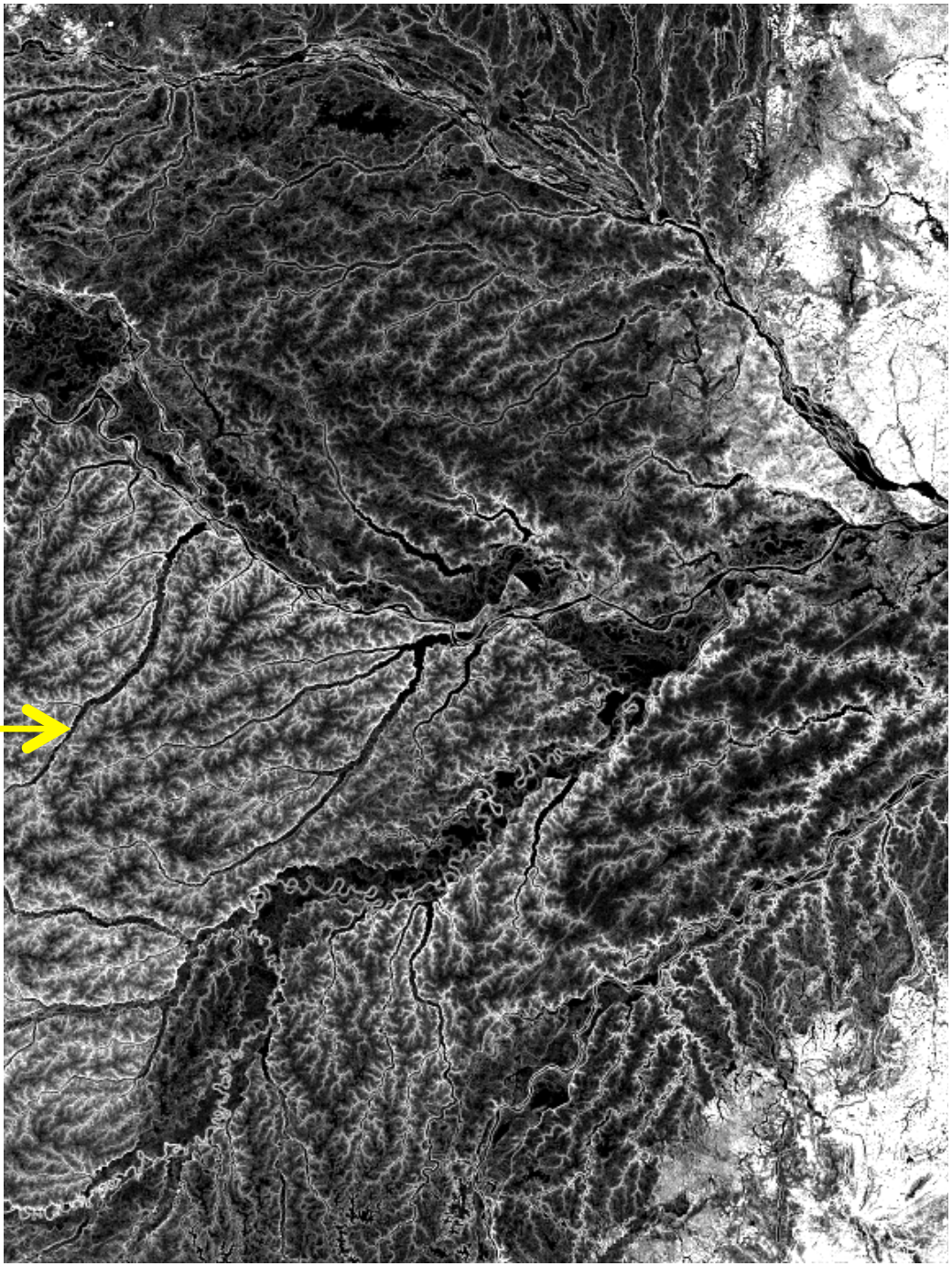
Testable:

- by other taxa
- by geology

Ribas et al. *PRS* 2012

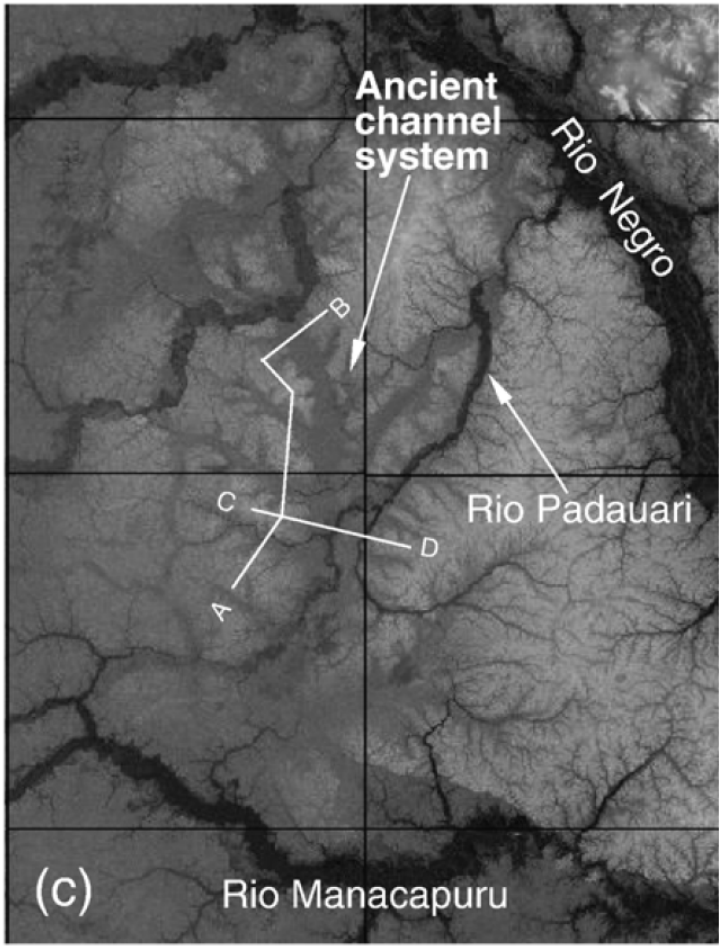
Integrating paleogeography and remote-sensing using SRTM





SRTM
% slope at 5 km scale

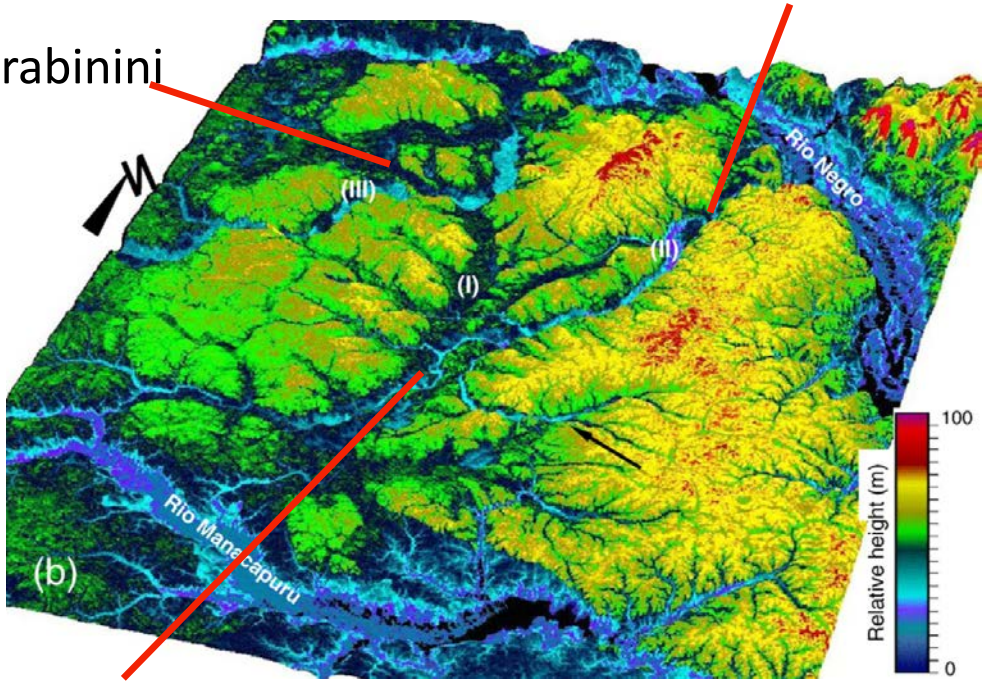
SRTM and Rio Negro paleogeography



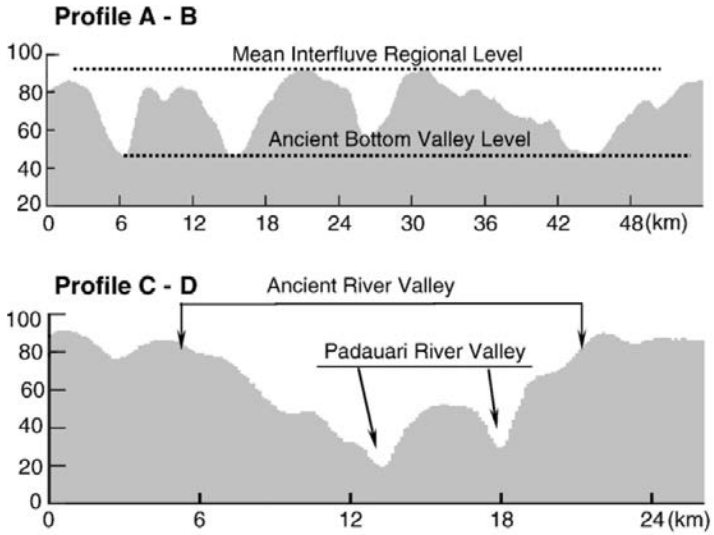
SRTM digital elevation model

Rio Padauari

Rio Carabinini



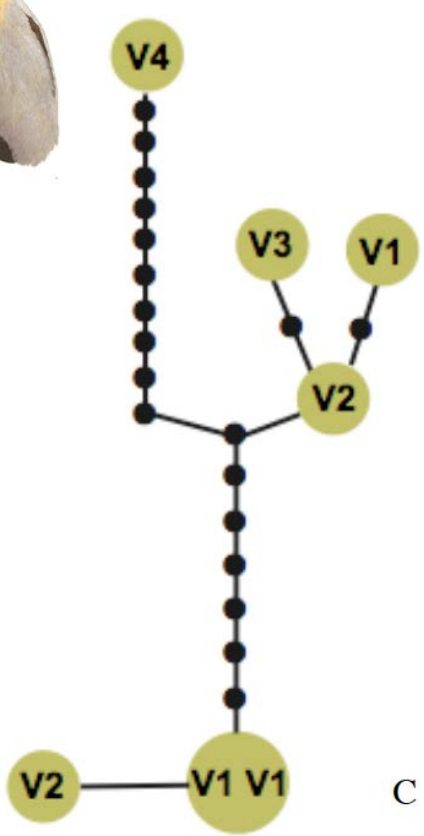
paleoriver

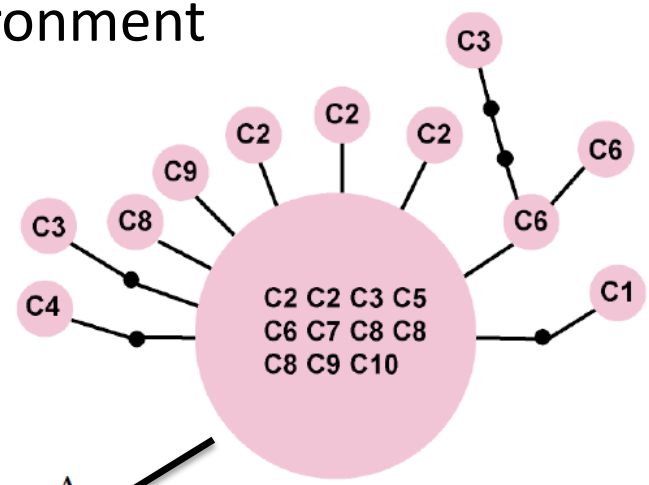


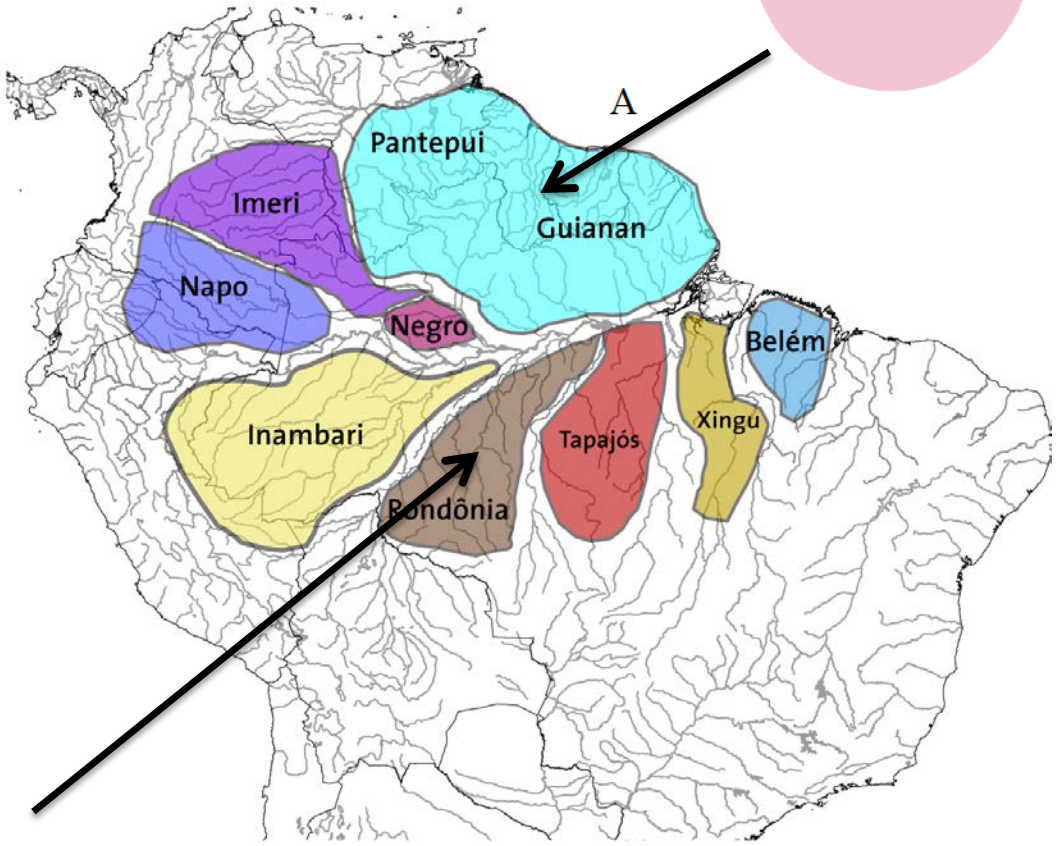
Almeida-Filho & Miranda. 2007. *Remote Sensing Environ.* 110:387-392

Integrating phylogeographic (genetic) structuring with paleoclimatology & landscape modeling

P. crepitans: more unstable environment



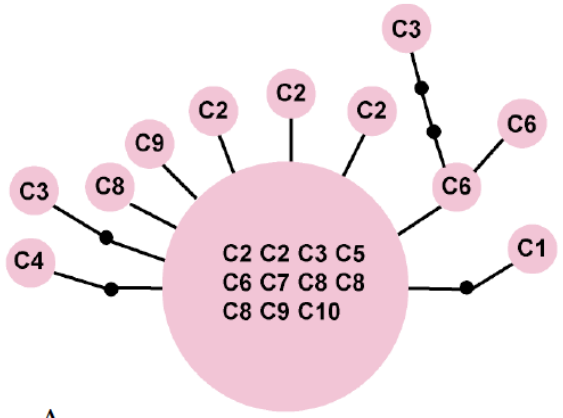




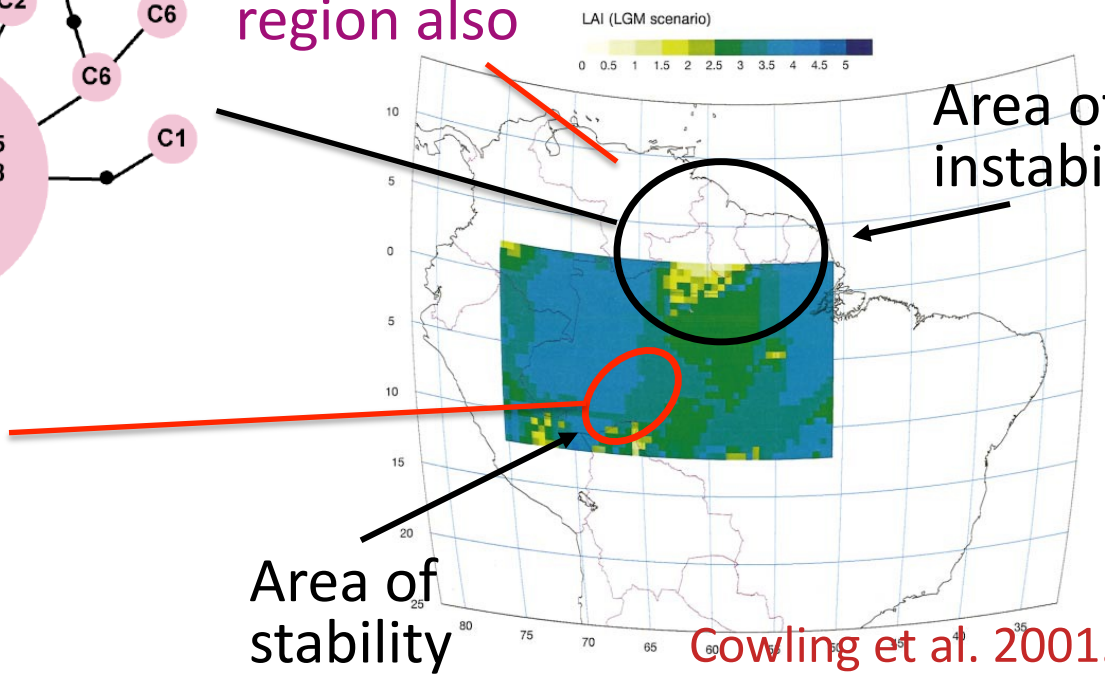
P. viridis: more stable environment

Inverse vegetation-climate modeling

LGM



New ~600 Kyr cores in the region also

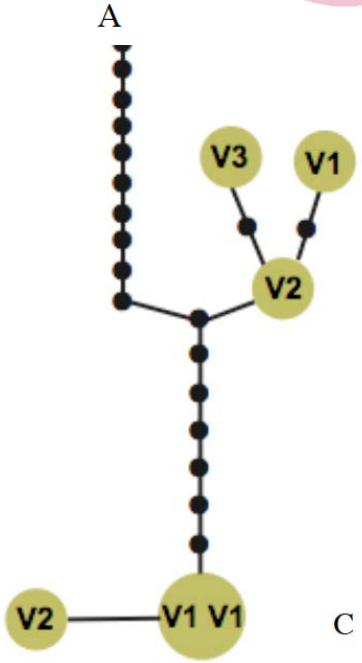


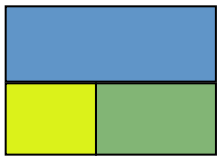
Area of instability

Area of stability

Cowling et al. 2001. *Quat. Res.* 55:140-149

(Cowling et al. 2001)





Continuous forest of high leaf area

Invading grasslands or woodland of low leaf area

Prescribed climate: 5ºC cooling, 20% reduction in precipitation (relative to today) and reduction in atmospheric CO_2 (200 ppmv)

Other ongoing activities

- Assembled ~500,000 digital distribution records for birds & ~80, 000 primates. (Authority files: collection localities and geographical locations
- New postdocs, grad & undergrad students on board (Brazil programs: Science without Borders; CAPES)
- Other integrative activities moving forward:
  geology-palynology-paleoclimate
  phylogeography-environmental modeling
  phylogenetics-paleogeography
- Website is launched: www.amazoniabiodiversity.org